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A novel $CO^{18}O$ dataset and modelling framework to constrain estimates of photosynthesis at the global scale

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Photosynthesis (GPP), the largest CO_2 flux from the land surface, is currently estimated with considerable uncertainty. More robust estimates of global GPP could be obtained from the atmospheric budgets of other tracers such as, the oxygen isotopic composition ($\delta^{18}O$) of atmospheric CO_2 or carbonyl sulphide (COS). However, estimating GPP using these tracers hinges on a better understanding of how soil microbes modify the atmospheric concentrations of $CO^{18}O$ and COS at large scales. In particular, understanding better the role and activity of the enzyme Carbonic Anhydrase (CA) in soil microbes is a critical factor underpinning the successful implementation of these tracers in global scale models. We addressed this knowledge gap by measuring the exchange of $CO^{18}O$ between soil microcosms and the atmosphere from sites covering a range of biomes. This novel dataset has led to the development of a new mechanistic framework that can be easily implemented in multi-tracer Earth system models to predict variations in soil CA activity across the terrestrial land surface. Using this multi-tracer approach we provide independent estimates of global GPP constrained by the atmospheric budgets of CO_2 and $CO^{18}O$.